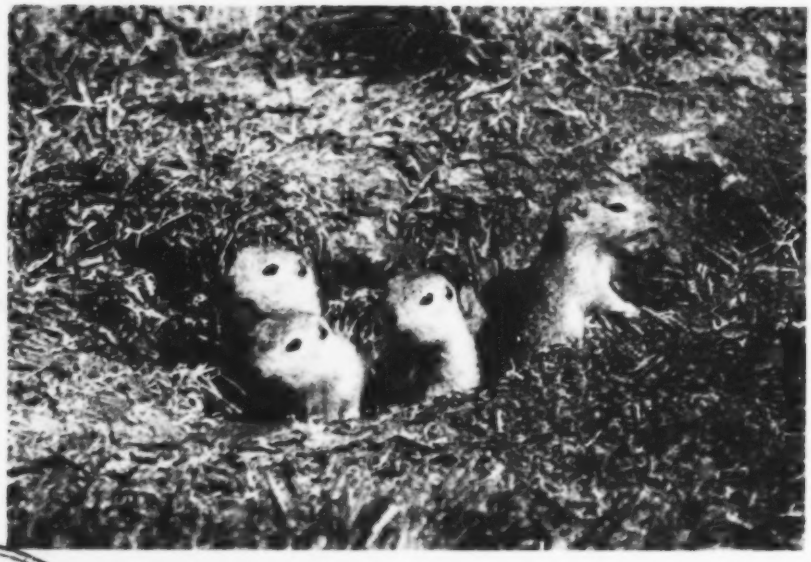
Fish & Wildlife Division

WILDLIFE CONSERVATION AND BIODIVERSITY SECTION

Survey Protocol for the Richardson's Ground Squirrel



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Alberta
SUSTAINABLE RESOURCE DEVELOPMENT

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Survey Protocol for the Richardson's Ground Squirrel

Brad A. Downey

March 2003

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EXECUTIVE SUMMARY

Richardson's ground squirrels (*Spermophilus richardsonii*), colloquially known as "prairie gophers", are found throughout the prairie provinces and play a vital role as a prey species for several predators. In the case of ferruginous hawks, Richardson's ground squirrels make up 89% of the prey biomass (Schmutz and Hungle 1989), so management for this and other raptor species should include studies on their main prey. Behavioural and physiological ecology of Richardson's ground squirrels is fairly well known (Michener 1998, Michener 2002a), but information on population trends in the prairies is less well documented (Schmutz and Hungle 1989, Kirk and Banasch 1996). Population trends have been investigated for Richardson's ground squirrels, other species of ground squirrels, and prairie dogs to determine how prey populations affect their main predator (Schmutz and Hungle 1989, Menkens et al. 1990, Van Horne et al. 1997, Powell et al. 1994).

Past surveys on ground squirrels included burrow entrance counts, mark-release-recapture, and above ground visual surveys. Above ground visual surveys during playback of alarm vocalisations has been selected as the preferred survey method for Richardson's ground squirrels because it is time efficient and cost effective and should yield the required information. Thirty existing ferruginous hawk blocks were selected to have 12.8 km (8 mile) Richardson's ground squirrel transects placed within them. The surveys will be conducted along these transects during the first three weeks of April when adults are above ground and juveniles have not yet emerged. Surveys will be conducted during specific times of the day and under specified weather conditions when ground squirrels are most active. A second survey may be conducted in June to determine whether population trends in April and June are similar. Analyses of the data will look at whether there are any differences in the number of ground squirrels seen using call playback versus no call playback. Yearly trends using route regression analysis will be calculated for the entire grassland region, each of the five survey areas (Hanna, Brooks, Lethbridge, Medicine Hat, and the Foothills Fescue Region), and the 30 individual hawk blocks.

1.0 INTRODUCTION

Richardson's ground squirrels (*Spermophilus richardsonii*) are distributed throughout the grasslands and are a key component to the prairie ecosystem. Smith (1993) and Michener (1996, 2002a) identify Richardson's ground squirrels as a vital prey source for ferruginous hawk (*Buteo regalis*), Swainson's hawk (*Buteo swainsoni*), prairie falcon (*Falco mexicanus*), prairie rattlesnake (*Crotalus viridis*), American badger (*Taxidea taxus*), and long-tailed weasel (*Mustela frenata*). Their burrows also provide refuge and shelter for burrowing owls (*Athene cunicularia*), bumblebees, several species of snakes, and small mammals (Michener and Schmutz 2002). Several researchers have identified the importance of surveying for prey species, such as ground squirrels and prairie dogs, to identify their influences on the predator species that are closely linked to them (Schmutz and Hungle 1989, Menkens et al. 1990, Powell et al. 1994, Kirk and Banasch 1996, Van Horne et al. 1997). Because Richardson's ground squirrels play an important role in the overall biodiversity of the grassland ecosystem a consistent and practical system of monitoring ground squirrel populations is required.

Survey methods used in the past for ground squirrels include burrow entrance counts, mark-release-recapture, and above ground visual counts, but no standardised method has been developed for Richardson's ground squirrels in the grassland region of Alberta. Such a survey needs to be cost effective, time efficient, and be linked to other surveys as part of a grassland-monitoring program. Because Richardson's ground squirrels are widely distributed at different population densities in a wide variety of habitats across the prairies, an estimate on their entire population would be impractical. A more practical goal is to track annual fluctuations in the prairie-wide population by monitoring selected areas. Therefore objectives were identified for a survey which could be conducted yearly at modest investment of cost and time.

- To review the biology and ecology of Richardson's ground squirrels
- To review and compare potential survey methods for application to Richardson's ground squirrels
- To develop a survey methodology to determine yearly trends in population density of Richardson's ground squirrels in Alberta.
- To develop a survey method that can compare trends in Richardson's ground squirrel populations with trends in the ferruginous hawk populations.

Surveys conducted in the past on Richardson's ground squirrels were usually tied into surveys for other species, particularly ferruginous hawk (Schmutz 1989), prairie falcon (Usher et al. 1993), or burrowing owls (Russell 2002, Scobie 2002). Continued multi-species surveys are an effective means of allocating time to surveys. This protocol highlights three survey methods: burrow entrance counts, mark-release-recapture, and point count visual surveys using call playback. It also identifies the reasons why one of

these methods was selected over others. The time allocation, manpower required, cost, and precision are estimated for each method and rated as high, medium, or low.

2.0 BIOLOGY AND ECOLOGY OF RICHARDSON'S GROUND SQUIRRELS

2.1 Physical Description

The Richardson's ground squirrel is a medium-sized rodent that weighs 250-550g, depending on sex and time of year (Figure 1). Richardson's ground squirrels are identified by their small furry ears, furry tail, large eyes placed high on the head, and sandy brown or buffy yellow colour with darker hairs on the back giving a mottled appearance (Smith 1993).

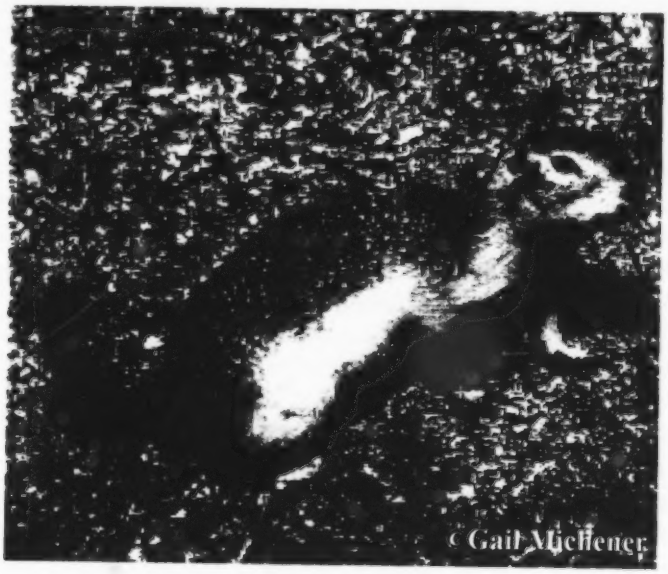

Figure 1. Juvenile Richardson's ground squirrel

2.2 Phenology

Male and female ground squirrels are active at slightly different times of the year. Around Lethbridge in southern Alberta, adult males usually emerge from hibernation in late February to early March, and adult females emerge about two weeks later. Adult males then re-enter hibernation (immerge) around mid-June and adult females immerge in late June- early July (Michener 2002a). Juveniles usually first appear above ground in early to mid-May and remain active until early to mid-August for juvenile females and mid-September to October for juvenile males (Michener 2002a, Figure 2). The active season begins 2-3 weeks later in more northerly locations in Alberta. Furthermore, at any location timing of the active season can vary 2-3 weeks between years depending of the severity of the winter (Michener and Schmutz 2002).

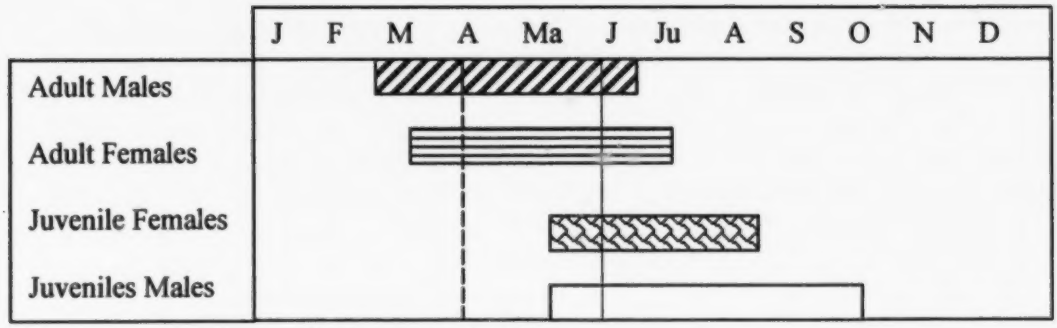
J F M A Ma J Ju A S O N D
Adult Males
Adult Females
Juvenile Females
Juveniles Males
April -survey only adults
June- survey entire population (Presence of adult ground squirrels and attrition of juveniles may vary between years)

Figure 2. Average times of emergence from hibernation (adults), emergence from the natal burrow (juveniles), and immergence into hibernation for Richardson's ground squirrels in Alberta (after Michener 2002a). The dashed line indicates the optimal time to conduct surveys to count the number of adults. The dotted line indicates a second time at which surveys could be conducted.

Richardson's ground squirrels spend about 85% of their life below ground sleeping and hibernating and are active above ground for only 15% of their life (Michener 2002b, Michener and Schmutz 2002). They become sexually mature at one year of age. Females are only capable of having one litter per year; even if they lose at litter during pregnancy or lactation, females cannot produce another litter until they hibernate again (Michener 2002a). Mating occurs shortly after females emerge from hibernation. Because females tend to emerge and mate synchronously, all litters are born within a 1 to 3 week period, so all the young ground squirrels appear above ground at roughly the same time. This results in a dramatic increase in the number of animals above ground within a matter of days. However, few young survive to adulthood (10-20% of the males and 40-50% of the females) due to predation and other natural causes of mortality (Michener and Schmutz 2002).

2.3 Habitat Requirements

Richardson's ground squirrels are opportunistic and occur not only in their natural prairie habitat but also in native pastures, tame pastures, cultivated fields, hay land, parkland, parks, farmyards, and ditches. They are found in the highest numbers in flat heavily grazed areas and in smaller numbers in taller vegetation (Michener and Schmutz 2002). Ground squirrels can persist on islands of grassland or along ditches surrounded by cultivation (Michener 2002a). A key limiting factor to their habitat requirements may be the type of soil in which they construct their burrows. They do not inhabit sandy or clay soils in which tunnels are prone to collapse (Reynolds et al. 1999). In the locations where they are in sandy soil, Reynolds et al. (1999) found them to be along roadways where the compaction of the area during road construction caused the soil to be stable enough for the excavation of burrows. Ground squirrels are sometimes found in sandy well-vegetated soils.

An adult female ground squirrel maintains a home range of up to 240m² in the summer. Home ranges of females often overlap with those of their close female relatives such as sisters or daughters (Michener 2002a). Home range for males vary throughout the year. During the breeding season the males home ranges can overlap the areas used by as many as 10 females, however after the breeding season males are restricted to small areas by the aggression of pregnant and lactating females (Michener 2002a).

2.4 Distribution

Richardson's ground squirrels are found throughout the prairie provinces in Canada and in North Dakota, South Dakota, Montana, and western Minnesota in the United States (Michener 2002a). In Alberta their range extends from the Saskatchewan border west to the foothills where they give way to Columbian Ground Squirrels *(Spermophilus columbianus)* and from the United States border to north of Edmonton (Figure 3).

Figure 3. Distribution of Richardson's grounds squirrels in Alberta (after Smith 1993)

3.0 SURVEY METHODS USED IN THE PAST

3.1 Burrow Entrance Counts

Surveys such as counts of burrow entrances have been used to determine population density trends for semi-fossorial mammals. Van Horne et al. (1997) conducted burrow entrance counts in western Idaho on Townsend's ground squirrels *(Spermophilus townsendii)* to determine spatial and temporal population trends. Burrow entrance counts were ineffective at detecting small or moderate yearly fluctuations in population densities. Errors in population estimates arise because burrows persist over time even when not in use, several ground squirrels may use one burrow system, and other species

may occupy burrows not in use by ground squirrels. Furthermore discrepancies in counts occur between observers (Powell et al. 1994, Van Horne et al. 1997).

Van Horne et al. (1997) found that number of burrow entrances and the density of ground squirrels were not significantly related. They recommended that burrow entrance counts not be used for determining a population trend for Townsend's ground squirrels in shrub steppe habitat and should be verified prior to being conducted in other habitats. Because burrow entrance counts are imprecise at determining yearly fluctuations, have high observer bias (counting inactive burrows as active), require access to private land, and require substantial time and manpower this survey was ruled out (Table 1).

3.2 Mark-Release-Recapture

Mark-release-recapture is the usual means of acquiring absolute density estimations for small mammals. Although mark-release-recapture is useful in determining yearly population trends of ground squirrels, the technique is very costly and labour intensive (Van Horne et al. 1997). Personnel would have to be consistently monitoring the traps and handling the animals for marking. Access to private land would also be required. Consequently this survey method is not feasible for yearly monitoring of Richardson's ground squirrels (Table 1).

3.3 Point Site Visual Surveys

Above ground surveys of ground squirrels and prairie dogs have been conducted by several individuals and groups (Lishak 1977, Menkens et al. 1990, Powell et al. 1994, Hare and Atkins 2001). Menkens et al. (1990) suggests that visual counts of white-tailed prairie dogs (*Cynomys leucurus*) are capable of providing indices of population densities. Point site visual surveys are a quick and simple means of sampling large areas in short periods of time. They are low cost, do not require traps, and are repeatable yearly. Less time is required compared to burrow entrance counts, landowner permission is rarely required, and populations can be observed from afar. Limitations include the survey being restricted to certain times of the day and year when ground squirrels are active and the effect of topography or vegetation on visibility. Time, manpower, and cost are relatively low compared to the other two methods (Table 1).

Table 1. Comparison of survey methods

Survey Method	Time Allocation	Manpower	Cost	Precision
Burrow Entrance Counts	High	High	Low	Low
Mark and Recapture	High	High	High	High
Point Site Visual Surveys Using Call Playback	Medium	Low	Low	Medium

Above ground visual surveys can be imprecise when surveys are conducted during inappropriate times such as periods of low activity above ground or when there is a

dramatic change in the population size. Changes in population size can be due to emergence of juveniles from natal burrows, dispersal of juveniles, or staggered times of immergence into hibernation among age and sex classes (Menkens et al. 1990). The following protocol targets the small window of opportunity when activity levels of the ground squirrel population are high and when only adult ground squirrels are above ground. Yearly differences in the timing of mating and the emergence of young would be a concern with later surveys. Emergence of young may vary 2-3 weeks between years and geographic location (Michener and Schmutz 2002). Surveys of adults conducted during the first three weeks in April will alleviate any biases arising from whether or not juveniles are active above ground and simplify the task by just counting adults. Because females can only have one litter a year and because adult females outnumber males by at least 3:1, counts of adults in April should most accurately reflect the size of the reproductive population (G. Michener pers. comm.).

3.4 Call Playback Surveys

Animal calls have been used for centuries as a means to attract or bring about a response from selected species (Lishak 1977). Most calls were and still are used for hunting purposes however calls are now incorporated into regular wildlife surveys (Lishak 1977). The use of high-pitched whistles or natural alarm calls helps to increase observability of ground squirrels (Leung 1991, Lishak 1977, Hare and Atkins 2002). Alarm calls have allowed researchers to count 63%- 100% of the thirteen-lined ground squirrels (*Spermophilus tridecemlineatus*) actually residing in a population (Lishak 1982). Surveys using call playback for thirteen-lined ground squirrels proved very effective; he counted 44-47% more ground squirrels during call playback versus no call playback (Lishak 1977)

Hare and Atkins (2001) studied the response of Richardson's ground squirrels to alarm calls in Manitoba. They noted that the ground squirrels responded to the calls with increased vigilance either by standing upright to scan the area or remaining on all fours with their head elevated. This was similar to Lishak's results in which thirteen-lined ground squirrels either ran to their burrow and erected themselves to scan the horizon, erected themselves where they were, or responded loudly to the call playback.

The viability of such a method for surveying Richardson's ground squirrels will be evaluated through these surveys.

4.0 SELECTED SURVEY PROTOCOL

4.1 Survey Assumptions

It is important that the following survey assumptions are met so that any biases will be consistent. This will allow accurate calculation of trends and comparisons between areas (Ministry of Environment, Lands and Parks Resource Inventory Branch 1998).

- Surveys will be far enough apart so as not to influence each other.

- Survey protocol will be followed consistently.
- Sampling will not occur during periods of drastic changes in the population size (i.e. when juveniles are emerging or when adults are entering hibernation). By sampling at the start of April only the adults will be above ground.
- All ground squirrels in the 200m radius have an equal chance of being seen.
- Ground squirrel movements during the count are minimal so that double counting is minimized.
- Surveys will be conducted yearly during the first three weeks of April to develop consistent yearly trend data for the adult population.

4.2 Point Site Visual Surveys

This survey method was designed so it could be conducted in conjunction with ferruginous hawk block surveys. Schmutz and Hungle (1989) found strong correlation between ferruginous hawks and the number of ground squirrels. Surveying for both species may help us to understand the amount of which ferruginous hawk populations fluctuate due to changes in the ground squirrel population.

Point site surveys involve an observer driving and stopping every 800m along a 12.8km (8 mile) predetermined transect. One 12.8km transect will be conducted yearly in 28 of the existing ferruginous hawk blocks, five to eight blocks in each of the four Fish and Wildlife areas (Hanna, Brooks, Lethbridge, and Medicine Hat) and an additional two ferruginous hawk blocks in the foothills fescue sub-region (Figure 4). Twenty-eight of the total 30 blocks were also selected as candidates for yearly ferruginous hawk monitoring (Taylor 2003). The ferruginous hawk blocks of 6.4km by 6.4km (4 miles by 4 miles) are scattered throughout the grassland region of Alberta.

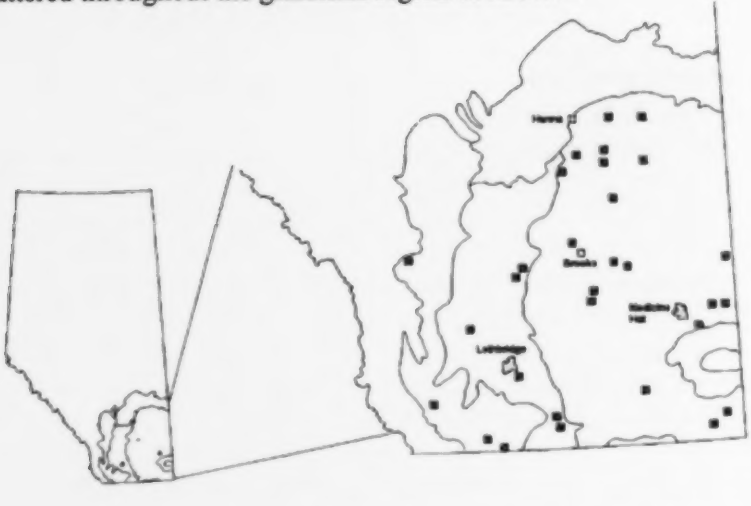

Figure 4. Ferruginous hawk blocks with Richardson's ground squirrel transect.

The observer will use binoculars and start the survey at a recognisable point then rotate around 360 degrees (four 90° quadrants) counting each ground squirrel within 200m during a 2 minute period. In cases where quadrants cannot be surveyed 200m due to obstructions resulting from topography the observers will continue along the transect (up to 400m from the original site) until they can see 200m in each quadrant. Any changes in the locations of the stops will be noted on the data sheet. Regular intervals of stops every 800m will then continued from where the original stop was located. The number of Richardson's ground squirrels seen in each quadrant (NE, NW, SE, and SW) will be recorded on the data sheet (Appendix A). The dominant habitat for each quadrant and the habitat in which ground squirrels are seen will be recorded. Any other objects or disturbances seen within the 200m survey radius will also be recorded under the column "Disturbances".

4.3 Call Playback Survey

On completion of the first count the observer will then play a recording of the alarm call of an adult Richardson ground squirrel for 30 seconds while facing each quadrant and counting the number of ground squirrels observed. Both counts will be recorded to determine whether playback of alarm calls assists in increasing observability.

The observer will record species of interest (Appendix B) encountered at the stop (e.g. loggerhead shrike *Lanius ludovicianus* and upland sandpiper *Bartramia longicauda*) and species that may affect a ground squirrel colony (e.g. American badger *Taxidea taxus* and coyote *Canis latrans*). At each site, the observer will also record whether a colony (group of burrows) or an individual burrow exists in each of the quadrants surveyed. The detailed survey method is provided in Appendix C.

4.4 Survey Conditions

Surveys will be conducted during the first three weeks of April to ensure that all adult ground squirrels have emerged from hibernation and are above ground. This will allow the maximum adult density to be assessed each year. Surveys for relative abundance to be used for trend data should be conducted when the largest counts are possible as with the emergence of juveniles (Ministry of Environment, Lands and Parks Resource Inventory Branch 1998). However emergence of young may vary 2-3 weeks between years depending on the severity of the winter and geographic location (Michener and Schmutz 2002). April surveys of adults were chosen to alleviate the biases that could result from these fluctuations. Surveys, if time allows, may be repeated during the ferruginous hawk block surveys to see whether trends from April counts of adults reflect the relative abundance in June when juveniles have emerged.

Surveys will be conducted when ground squirrels are actively feeding. Morning surveys will start 75 minutes after sunrise and end by 1200 hours. Afternoon surveys will be conducted from 1600 hours until 75 minutes prior to sunset. Because of reduced levels of activity, surveys will not occur during extremely high temperatures (30 °C) or inclement weather such as snow or rain (NatureServe Explorer 2001, G. Michener pers. comm.). Wind, which seems to be a limiting factor in all surveys where call playbacks are used,

may not be as great a factor for ground squirrel surveys. This is based upon the assumption that when the alarm call is played squirrels hearing the call will then emit their alarm call to warn others that may not be able hear the primary one. However, surveys should not be conducted in winds over four on the Beaufort Scale (Appendix D).

4.5 Data Sheet Components

- Wind speed will be based on the Beaufort Scale and observers will circle the code that corresponds with the wind speed. Descriptions are also given for each code to assist the observer in selecting the appropriate code in case they have no wind gauge (Appendix D).

- Air temperature (°C) and time (24-hour clock) will be recorded at the start and end of each 12.8km transect.

- Percent cloud cover will be recorded to the closest 10%.

- UTM co-ordinates will be taken at each 800m stop using GPS units (NAD 83).

- Observers will divide each survey site into four quadrants (NE, NW, SE, and SW) and record the number of Richardson's ground squirrels seen within 200m and the habitat they were seen in for each quadrant. Habitat codes are provided at the bottom of the data sheet.

- Observers will record any disturbances within 200m for each quadrant. Disturbance codes are provided at the bottom of the data sheet.

- Two counts will be conducted, one without and one with call playback (First count #, Call playback #). Each count will take two minutes. This will allow evaluation of the effectiveness of the call playback survey.

- Observers will record and burrows seen at each stop.

- Observers will record any additional species seen (Appendix B).

4.6 Data Analysis

Data collected from ground squirrel surveys will be used to develop yearly trend data for the entire grassland population, for each of the five areas (Hanna, Brooks, Lethbridge, Medicine Hat and the Foothills Fescue Region), and for the individual blocks. The two counts, one without and one with the use of call playback, are taken so that a paired t-test can be conducted to determine whether the number of ground squirrels seen differs statistically between the two methods. Route regression analysis will also be conducted to determine statistically yearly trends in the population. Richardson's ground squirrel trends will then be compared to ferruginous hawk trends to determine similarity in

population fluctuations over time. This information may also be used to understand how fluctuations in ground squirrel populations may affect ferruginous hawk populations.

4.7 Survey Protocol Evaluation

An evaluation of the survey will occur after one year to determine whether visual counts without call playbacks are necessary. If deemed that surveys with call playback result in higher numbers of ground squirrels the surveys with no call playback will then be removed from the survey protocol. Upon the third year and subsequent years a statistical analysis will be performed and evaluated on the data. Changes in the statistical methods used may also occur depending on the results of the evaluation. A full review and evaluation of statistical methods and survey protocols will occur in 2008.

5.0 EQUIPMENT NEEDED

- Data Sheets: Appendix A
- List of Other Species: Appendix B
- Clipboard
- GPS unit (NAD 83)
- Pencil
- Thermometer
- Alarm Call Tape/CD
- Caller (Johnny Stewart, Dennis Kirk, Large Ghetto Blaster, etc)
- Binoculars
- Scope (recommended)
- Wind Gauge (recommended)
- Range Finder (recommended)

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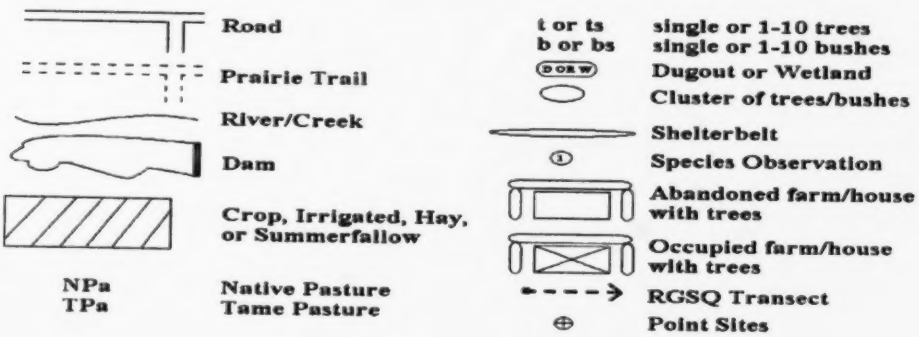
APPENDIX A

(Richardson's ground squirrel survey map and data sheet)

FEHA Block #: **Observer:** **Date (dd/mm/yy):**

Meridian: **TWP:** **RGE:** **SE Section of Block:**



Richardson's ground squirrel data sheet

FEHA Block #:_____ **Observer:**_____

Date (dd/mm/yy): **Time (Start):** **(End):**

Weather: Sunny Partially Cloudy Rain Overcast **Temperature (°C) (Start):** **(End):**

Wind (Beaufort Scale): 1 2 3 4 5 6 >6

% Cloud Cover: 1-10 11-20 21-30 31-40 41-50 51-60 61-70 71-80 81-90 91-100

GPS Location (NAD 83)		Stop #	Number Seen (First Count, Call Playback Count)		*Habitat (Mark two habitat types if ground squirrels location differs from the main habitat type)		**Disturbances		Ground squirrel colony (Y/N)		Other Species
Northing	Easting										
		1	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		2	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		3	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		4	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		5	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		6	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		7	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		8	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		9	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		10	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		11	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		12	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		13	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		14	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		15	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		16	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					
		17	NW: ,	NE: ,	NW:	NE:					
			SW: ,	SE: ,	SW:	SE:					

*C= Crop, Npa= Native Pasture, Tpa= Tamed Pasture, H= Hayland, F= Farmyard, ABF= Abandoned Farmyard, D= Ditch, IC= Irrigated Crop, IP= Irrigated Pasture, O= Other

** W= Well Site, R= Road Adjacent, FL= Fence Line, PL= Power Line, DUG= Dugout, PIP= Pipe Line DIS= Other disturbance

APPENDIX B

Other species list (Alberta Sustainable Resource Development 2001)

Common/Latin names	Code to use on data sheet
American Badger/ *Taxidea taxus*	BADG
Baird's Sparrow/*Ammodramus bairdii*	BDSP
Bald Eagle/*Haliaeetus leucocephalus*	BAEA
Bobolink/*Dolichonyx oryzivorus*	BOBO
Bullsnake/ *Pituophis catenifer*	BULL
Burrowing Owl/ *Athene cunicularia*	BUOW
Coyote/ *Canis latrans*	COYO
Ferruginous Hawk/ *Buteo regalis*	FEHA
Golden Eagle/*Aquila chrysaetos*	GOEA
Great Blue Heron/ *Ardea herodias*	GBLH
Lark Bunting/*Calamospiza melanocorys*	LKBU
Loggerhead Shrike/ *Lanius ludovicianus*	LOSH
Long-Billed Curlew/ *Numenius americanus*	LBCU
Long-Tailed Weasel/ *Mustela frenata*	LTWE
Mountain Plover/*Charadrius montanus*	MTPL
Peregrine Falcon/ *Falco peregrinus*	PEFA
Prairie Falcon/ *Falco mexicanus*	PRFA
Prairie Rattlesnake/ *Crotalus viridis*	PRRA
Pronghorn/*Antilocapra americana*	PRON
Red Fox/ *Vulpes vulpes*	REFO
Red-tailed Hawk/ *Buteo jamaicensis*	RTHA
Sage Grouse/ *Centrocercus urophasianus*	SAGR
Sage Thrasher/*Oreoscoptes montanus*	SATH
Sandhill Crane/ *Grus Canadensis*	SACR
Sharp-tailed Grouse/*Tympanuchus phasianellus*	STGR
Short-eared Owl/*Asio flammeus*	SEOW
Sprague's Pipit/*Anthus spragueii*	SPPI
Swainson's Hawk/ *Buteo swainsoni*	SWHA
Swift Fox/ *Vulpes velox*	SWFO
Thirteen-lined Ground Squirrel/*Spermophilus tridecemlineatus*	TLGS
Trumpeter Swan/*Cygnus buccinator*	TPSW
Upland Sandpiper/ *Bartramia longicauda*	UPSA
Whooping Crane/*Grus americana*	WOCR

APPENDIX C
Survey summary sheet

- The survey period will occur during the first three weeks of April.
- Surveys will take place from 75 minutes after sunrise until 1200 hours and then from 1600 hours until 75 minutes prior to sunset. These are the most active times for ground squirrels.
- No surveys will take place during extreme temperatures (>30°C) or days with adverse weather conditions (i.e. rain, snow, or strong winds (>4 on the Beaufort scale) etc).
- Stops will be 800m apart, except in cases were visibility is restricted due to topography. In these cases the observer will continue along the transect up to 400m (the shorter the better) from the original site until 200m in each quadrant can be surveyed. Regular stops every 800m will then be continued from where the original stop was located.
- Observers will count the number of ground squirrels seen during a 2-minute period, 30 seconds in each quadrant (NE, NW, SE, and SW), within 200m of their position with the aid of binoculars starting at one point and rotating around 360°.
- The number of Richardson's ground squirrels seen for each quadrant will be recorded on the data sheet.
- A call playback will then be used with the observers playing the call for 30 seconds towards each of the quadrants. Each quadrant will be recounted and the number of Richardson's ground squirrels seen will be recorded again on the data sheet adjacent to the first count (first count #, call playback count #) during the 30 second call playback.
- Habitat information and any disturbances will be recorded for each quadrant.
- GPS, northing and easting (NAD 83) locations will be taken at each stop.
- Any additional wildlife listed in Appendix B will be recorded at each site. Any additional species seen which do not occur on the list but which the observers deem important will be recorded.
- The observer will identify whether there is a colony (group of mounds) within each quadrant at each stop by marking yes (presence) or no (absence) in the column provided.

APPENDIX D
Beaufort Scale

Code	Wind Speed		Beaufort wind description
	kph	mph	
0	0-2	0-1	Calm, smoke rises vertically
1	3-5	2-3	Light air, smoke drifts
2	6-11	4-7	Slight breeze, wind felt on face; leaves rustle
3	12-19	8-12	Gentle breeze, leaves and small twigs in constant motion
4	20-30	13-18	Moderate breeze, small branches sway; dust and loose paper rise
5	31-39	19-24	Fresh breeze, small trees in leaf sway; thin branches sway
6	40-50	25-31	Strong breeze, large branches in motion

(Scale continues to 12, however for simplicity only the first 6 are shown)

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